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OPTIMIZING THE REMOTELY PILOTED AIRCRAFT PILOT CAREER FIELD

by

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Preface

During Operation Iraqi Freedom (OIF), my F-15E Strike Eagle squadron was occasionally tasked to fly along Iraqi oil and power lines to spot insurgent activity. Gaining and maintaining the necessary sensor locks on these structures while flying at high speeds and low altitudes was a challenge, even for the two-person crew of a mighty Strike Eagle. These sorties were among my first "remotely piloted aircraft (RPA) appreciation moments" as an F-15E Weapon Systems Officer (WSO).

During my tour as a Joint Undergraduate Navigator Training (JUNT) instructor, I learned how critical newly-winged WSOs are to the "health" of the Air Force's F-15E and B-1B communities. JUNT and Specialized Undergraduate Pilot Training students are much more than future aviators—they are the Air Force's future tactical, operational and strategic leaders.

These OIF and JUNT experiences led to my interest in the Air Force's new RPA pilot career field. I chose this topic to learn more about how manning policies can best be implemented to put the right people in the right cockpits, and keep them there. Many thanks to my research advisor, Dr. Richard L. Smith, of Air Command and Staff College, Maj Joshua "BASH" Cates, of the Air Force Personnel Center fighter assignments staff, and my fellow ACSC classmates for their support.

Abstract

The Air Force recently established a new "18X" RPA pilot air force specialty code (AFSC), separate from the traditional "11X" pilot AFSC. Graduates of the new 18X RPA pilot training syllabus receive limited flight training and do not hold the same aeronautical ratings of their traditional Air Force pilot colleagues in operational RPA squadrons. This paper explores two questions that are important to the success of the growing community of 18X pilots by using a problem/solution framework: First, what is the optimal rate of 18X pilot production? Second, what actions will foster the development of 18X leaders within the RPA community? Two rates of 18X pilot production are assessed using the limitations common to traditional pilot production. One is a conservative pilot-production rate and the other is a maximized rate. Despite technological challenges, a maximized rate will best meet the time-critical demand for RPA pilots. It will also increase 18X leadership opportunities and foster the development of an 18X "warrior culture".

INTRODUCTION

On June 7th 2006, two United States Air Force F-16s dropped precision-guided munitions on a safe-house near Baquba, Iraq, mortally wounding Abu Musab al Zarqawi, a top leader of al Qaeda in Iraq.[1] In a 2009 interview, Air Force Deputy Chief of Staff for intelligence, surveillance and reconnaissance (ISR), Lt Gen David A. Deptula, noted that Air Force surveillance drones observed the target for 6,000 hours in the weeks prior to the airstrike.[2] This operation underscores the increasing importance of drones, or remotely piloted aircraft (RPA),[a] in modern military operations. Their extensive loiter times and lack of onboard crews are well suited to many of the "dull, dirty and dangerous" missions previously flown by manned aircraft.[3]

The high demand for RPA pilots has historically been handled by sending "traditional" pilots[b]—those from manned-aircraft wings—on three-year RPA tours of duty, typically followed by a return to their primary aircraft units afterward. These tours are seen as burdensome by some pilots who are concerned over remaining tactically proficient and competitive for command positions in their manned-aircraft units.

The ever-increasing RPA pilot demand drove the creation of an RPA pilot production policy that improved upon past ad-hoc methods. In 2008, Air Force Chief of Staff, Gen Norton Schwartz, announced the creation of a separate RPA pilot career field, saying "The Air Force culture must promote a strong and healthy RPA community—not a leper colony or an agency of expedience, and these initiatives are just a first step toward that end."[4] The Air Force specialty code for career RPA pilots begins with the number 18 versus 11 for traditional pilots. The shorthand terms "18X", "18Xers", and "one eights" encompass three classes of RPA pilots:

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a. The author has changed most references from "UAV" (unmanned aerial vehicle) and "UAS" (unmanned aircraft system) to the current Air Force acronym "RPA" for readability.

b. Author's term.

18AX (attack RPA), 18GX (generalist RPA) and 18RX (reconnaissance RPA), and are commonly used to refer to both the new RPA pilot syllabus and the career field.

The *United States Air Force Unmanned Aircraft Systems Flight Plan 2009-2047* outlines the benefits of this new RPA career field:

> The USAF has researched multiple options to the challenges of sourcing, training, sustaining and "normalizing" of RPA pilots. . . . The USAF is testing a completely new training program with the goal to develop an RPA pilot career field with specialized RPA training distinct from current manned aircraft pilot training. A non-traditional pilot training path creates an additional source of RPA operators and relieves the RPA manpower burden on the current Specialized Undergraduate Pilot Training (SUPT) pipeline.[5]

In February 2009, the first class of RPA pilot candidates entered the introductory flight screening (IFT) program at Pueblo, Colorado, alongside traditional SUPT candidates.[6] These candidates were following a test or "beta" version of the RPA syllabus that differed from the SUPT syllabus in several ways. After 30 to 38 hours of light aircraft training, beta syllabus students received RPA-centered academics and a modest number of T-6 Texan II flight simulator events at Randolph Air Force Base, Texas. There were no syllabus flight events after IFT. The lessons learned over five beta classes were applied to the first formal class of 18X RPA student pilots, who entered training at Randolph in January 2011.

These events demonstrate the Air Force's goal of becoming the executive agency in Department of Defense (DoD) RPA operations.[7] Two critical issues during these developmental years of the 18X community are: 1) understanding the factors affecting the proper number of 18X pilots needed and 2) understanding the factors involved in developing RPA leaders from within the growing 18X community. This paper evaluates the Air Force's near-term and mid-term RPA manning options using a problem/solution framework. Courses of action based on

optimized benefits to both the Air Force and 18X pilots are compared and recommendations are offered.

BACKGROUND

RPA Types and Missions

The Air Force classifies its RPAs as small, medium or large. Medium and large RPAs bring increased resources to end-users, but require larger crews than small RPAs. A brief overview of each class follows, taken from the *USAF Unmanned Aircraft Systems Flight Plan 2009-2047* (henceforth referred to as the *Flight Plan*).[8]

Small RPAs

Small RPAs provide tactical ISR information, day or night, using electro-optical and infrared sensors. They are typically launched by hand or catapult and have limited range (tens of miles). Small RPAs can be hand-flown or operate semi-autonomously by flying pre-programmed Global Positioning Satellite routes and usually fly no higher than 3,000 feet at relatively slow speeds. Their real-time full-motion video (FMV) is invaluable to force protection efforts; they routinely provide FMV to personnel in convoys or on dismounted patrol. Small RPAs are typically piloted by enlisted airmen who are not required to possess the same aeronautical ratings as traditional Air Force pilots.[9] Small RPA manning is not a contributing factor to the focus of this paper.

Medium RPAs

The Air Force's MQ-1 Predator is a typical medium-sized RPA. Initially an ISR-only platform, the addition of wing hard points now allows carriage of bombs and missiles, expanding their growing list of roles to include that of "hunter-killers" of high-value, time-sensitive targets. The Predator and its larger variant, the MQ-9 Reaper, fly higher and longer than small RPAs via direct-line-of-sight ground station control, pre-programmed routes, or beyond-line-of-sight using

satellite links. Two-man Predator crews—an Air Force rated pilot[c] and an enlisted sensor operator—are in high demand for a wide range of missions such as ISR over-watch, close air support, combat search and rescue support, target development and precision strike. Missions can exceed 18 hours, requiring multiple crews for a single sortie.[10] The 18X training syllabus and career field was created in large part to meet the growing need for crews of this increasingly capable family of RPAs.

Large RPAs

Intended to replace the U-2 high-altitude reconnaissance aircraft, the RQ-4 Global Hawk is the Air Force's only operational large RPA.[11] Global Hawk carries an extensive array of ISR and communications equipment, which enables the sharing of information among large numbers of users and equipment—from cell phones and hand held radios to satellite data networks. Missions can exceed 24 hours, requiring multiple five-person crews for a single sortie: two rated pilots, a sensor operator, a quality control monitor and a communications technician.[12]

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More Roles for RPAs

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Rapid advances in RPA capabilities and their growing operational importance have been compared to the rise in prominence of aircraft carriers during the "battleship era" of early WWII or the development of US naval nuclear propulsion in the 1950s. Today's RPA units face the same challenge of the Navy's early carrier and nuclear submarine forces: build highly-skilled and motivated communities despite cultural and organizational barriers.[13]

The *Flight Plan* underscores the need for strong leaders to guide the RPA community:

> Due to the growth of RPA requirements and former policies of returning RPA qualified pilots back to manned aviation, there is a lack of RPA-expert leaders, decision-makers, and subject matter experts in key positions within (DoD) staffs.

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c. USAF navigators with FAA commercial pilot and instrument ratings fill some RPA pilot billets.

This shortfall has resulted in decisions that frequently are fragmented, reflect legacy culture, and limit innovation. In addition, RPA experience is needed to lead and motivate an RPA career track within the USAF. . . . Future RPA programs must grow experience from within. [14]

More Demand for RPA Pilots

Operations Enduring Freedom and Iraqi Freedom created an explosion in the demand for RPA missions and crews. Air Force Predator and Reaper 24-hour RPA combat air patrols (CAP) flown over Afghanistan and Iraq grew from five in 2001 to 50 in 2011. Creech Air Force Base, Nevada, is the Air Force's main stateside hub for the six RPA squadrons that support these CAPs through the use of satellite data links for RPA control and data transmission.[15] To meet the Air Force's goal of 65 total CAPs by 2013, ten additional RPA squadrons are planned: three active duty squadrons, six Air National Guard squadrons and one Air Force Reserve squadron.[16] The Air Force currently has 600 rated RPA pilots.[17] The *Flight Plan* estimates that 1,650 RPA pilots are needed by 2013 as part of a 15,000 airmen-strong RPA community, [18] with most of these pilots flying Predators and Reapers.[19] According to the *Flight Plan,* the reduction of US forces in Iraq and Afghanistan is not anticipated to slow the demand for RPA missions: "By 2015 every (US) state will have RPA flying sorties supporting DoD missions. As our nation brings home the forces deployed to Iraq and Afghanistan, a Joint RPA Center of Excellence study estimates that it will take 1.1 million RPA flight hours annually to stay prepared for future conflict".[20]

RPA Impact on Traditional Pilot Inventories

Demand for RPA missions is growing at an exponential rate. When Predator and Reaper combat hours passed the one million mark in early 2011, after 14 years of operations, Col James Gear, head of the Air Force's RPA task force, said the two million combat hour mark was only two and a half years away.[21] Past policies reflect the Air Force's challenges in meeting the insatiable demand for pilots of medium and large RPAs. In 2005, RPA pilot tour length was

increased from two to three years and then to three years plus training time in 2007.[22] By 2008, the Air Force was training more RPA pilots than F-16 pilots and was on track to have twice as many RPA pilots as F-16 pilots by 2011.[23] Before a "self-sustaining" inventory of 600 RPA pilots was achieved in July 2010, some RPA squadrons "froze" follow-on assignments for crews who were approaching the end of their tours.[24] This resulted in up to seven years of consecutive RPA service for some traditional pilots who were initially assigned to a single RPA tour.[25] The Air Force Personnel Center (AFPC) Chief of Operational Assignments described these manning solutions as "patchwork" adding that "the only mitigation is an RPA (pilot training syllabus)".[26]

Establishing the 18X career field is a carefully studied response to these problems. A 2005 Air Force Institute of Technology (AFIT) report on the impact of RPAs on fighter pilot manning explains how a properly balanced ratio of junior to senior fighter pilots keeps fighter squadrons "healthy". The factors used to determine this ratio are useful in discussing manning options for the nascent 18X community.

18X – A New Approach

The 18X training syllabus is designed to develop airmanship through flight training and simulator events, but at less cost and in less time than the year-long SUPT program. Volunteers for the 18X program are not required to have any previous flight experience, but applicants must pass an Air Force Flying Class IIU physical[d] that was developed from the more stringent SUPT Flying Class I physical.[27]

18X students begin their path to wings in the Air Force's Introductory Flight Training (IFT) course at Pueblo, Colorado. They progress through ground school and flight training in Katana light aircraft trainers, receiving 30 to 38 hours of introductory, night, cross country and solo

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d. "U" for unmanned

training to a point just short of that required to pass an Federal Aviation Administration (FAA) private pilot license check flight.[28] SUPT students receive around 200 more flight training hours over the next year in more advanced aircraft, while 18X students receive nine months of academic and simulator events at Randolph AFB's 558th Flying Training Squadron, which was reactivated in May 2010 to train future Predator, Reaper and Global Hawk crews. [29]

Randolph's RPA Instrument Qualification Course builds on the IFT syllabus to further develop airmanship through 30 to 40 hours of T-6 Texan II turboprop simulator events. Students then enter the RPA Fundamentals Course that is designed to teach basic operation of sensors, tactics, Air Tasking Orders, and various other skills needed to ensure their success in transitioning to the RPAs. They are paired with enlisted RPA sensor operator students for their final four events.[30] Upon graduation, newly-winged[e] Predator/Reaper and Global Hawk pilots enter initial qualification training courses (IQT) at RPA training squadrons.[31] Finally, IQT graduates are assigned to operational RPA squadrons.

Evaluations of 18X graduates have been positive. In a 2011 *Air Force Magazine* interview, Air Education and Training Command's director of intelligence, operations, and nuclear integration, Maj Gen James A. Whitmore, said their performance compared favorably with traditional RPA pilots, although he mentioned that the original number of Katana flights in IFT was doubled at the request of RPA squadrons after beta graduates had difficulties during subsequent training in their RPA units. "Time will tell on whether we've got it exactly right on the 18Xers and the new course. I suspect there'll be more tweaks that we need to do as we learn more about our graduates, but I think they're off to a pretty good start" added General Whitmore.[32]

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e. 18X graduates receive the newly-designed RPA pilot wings that are similar to the traditional pilot badge, but with an RPA-themed shield.

18X Benefits

In 2005, the total cost to produce an Air Force fighter pilot was more than $2.6 million. An airlift pilot required about $600,000—still more expensive by over a factor of ten when compared to the cost of the academic and simulator-heavy 18X syllabus. [33] Figure 1 from a 2005 *Air and Space Power Journal* article shows the impressive potential savings of a theoretical RPA syllabus. The 18X syllabus will get RPA pilots into operational squadrons vastly cheaper than by using traditional pilots from other communities, or by assigning SUPT graduates directly to RPAs.[34]

SUPT (fighter/bomber track)	$392,861
B-52 IQT	+292,190
Total	$685,051

Source: Air Combat Command/XOFT. This table uses a B-52 pilot as a valid sample of several Predator pilots, past and present, who maintain the B-52 as their MWS. Also, these figures do not include the cost of B-52 mission qualification training, B-52 requalification training after the Predator tour, survival schools, altitude-chamber training, life-support training, and so forth.

IFT	$5,500
Instrument rating	6,500
Hi-fidelity simulator check	+1,000
Total	$13,000

Source: Air Education and Training Command/ XOFT. The cost is only $1,000 if the nonrated selectee already possesses an instrument rating. The table does not include the cost of Predator IQT because a B-52 pilot under the old system would still have to attend Predator IQT; therefore, the cost would be the same.

Figure 1. Cost comparison of traditional vs. RPA syllabus pilots.[35]

The 18X syllabus will also drastically reduce the time needed for RPA pilots to reach operational status, compared to the training time of their SUPT and traditional pilot counterparts. Many traditional pilots who are sent to single RPA tours are "experienced" fighter pilots, defined in the Air Force as having logged 500 or more fighter aircraft flight hours.[36] The 2005 AFIT fighter/RPA manning study states that the time required for pilots to gain those 500 hours falls between a minimum of two years and three months to a maximum of two and a half years[f] (not

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f. A First Assignment Instructor Pilot (FAIP) requires only 300 flight hours in-type to be categorized as experienced in their FAIP tour follow-on aircraft. This takes an average of 15 to 16 months, depending on the aircraft.

including the average of two years spent in SUPT and other training courses, as mentioned in Figure 1).[37] The fact that typical RPA missions do not require many of the skills and training that experienced pilots possess (survival school, egress training, etc.) further increases the cost savings of the 18X syllabus.

The 18X syllabus is much more than a simpler, faster version of the SUPT syllabus. Cost savings will be lost if graduates struggle in their RPA training squadrons and require additional training sorties. Syllabus experts are working to identify the specific skills that RPA pilots must learn during training. Many of these skills will become clear only as 18X classes graduate and enter the operational Air Force. One example of this process is the increase in Katana IFT flight hours over the course of the five beta classes. The need for flight events in IFT or at Randolph AFB is not entirely settled, but they are likely to continue in IFT for the foreseeable future. Until technologies become available that can cost effectively recreate the inherent stress of piloting an aircraft, flight events will continue to be one of the best ways to assess students' knowledge of aircraft systems, flight rules, emergency procedures and their overall ability to properly handle unplanned situations under pressure (airmanship).

Relaxing the physical requirements for 18X pilots opens the candidate field to highly skilled and motivated officers who would otherwise excel in SUPT, but are unable to pass the required Class I flight physical. In a 2009 interview, Col Stephen Wilson, a former assistant operations officer with Air Education and Training Command who helped develop a forerunner to the 18X syllabus in 2006, expanded upon General Schwartz's "leper colony" remark. Colonel Wilson divided Air Force pilot culture into three tiers. "Tier one" pilots are top performers in their organizations and their commanders often strive to keep these individuals in the community. "Tier two" pilots perform well, but not up to tier one standards. "Tier three" pilots are

outperformed by their peers and can find themselves in assignments that may not align with their career goals.[38] Some traditional pilots consider RPA tours as suited only to "tier three" individuals. As RPA technology continues to mature, increasing RPA mission demands—and demand for RPA missions—will require skilled *and motivated* pilots to foster a strong RPA community. In his 2005 *Air Force Magazine* interview, General Whitmore reported that competition for 18X pilot slots was high—an encouraging sign that potential "tier one" personnel are being drawn to the 18X career field[39].

The Challenge: How Many 18X Pilots to Produce?

The 18X syllabus and career field is intended to address many manning issues, but ways forward on many others are yet to be determined. One basic question is: what ratio of 18X pilots to traditional pilots will best serve the developing RPA community? Similar to traditional pilot production, rapidly escalating the number of 18X graduates could create additional manning problems if not done wisely. Although there is not a perfect correlation between RPA manning issues and traditional pilot factors as described in the 2005 AFIT fighter/RPA manning study, commonalities will increase as RPA pilot production and training demands grow.

ANALYSIS

Three Pilot Inventory Variables

The 2005 AFIT fighter/RPA manning study defines a pilot inventory as all pilots from a group of similar aircraft, i.e. fighter, bomber, or airlift pilot inventories. The study details three common variables that affect the strength of Air Force pilot inventories: retention, requirements, and production/absorption. [40]

1. Retention

Retention is defined as the number of pilots who stay on active duty after their initial commitment. Retention will become increasingly important to the success of the 18X community as 18X pilots gain experience and rank, exposing them to career-broadening and leadership opportunities. This will strengthen the 18X community, but only if these pilots remain in the inventory past their initial commitments. This aligns with the *Flight Plan*'s direction to foster future 18X leaders from within.

2. Requirements

The Air Force Personnel Center divides traditional pilot requirements into four basic categories: 1) man-year requirements 2) force billets 3) training billets and 4) staff billets.

Man-year requirements account for pilots in the training "pipeline" (SUPT through completion of their primary aircraft's initial qualification training course), and pilots attending professional military education in-residence. After accounting for man-year requirements, AFPC gives top priority to filling force billets.

Force billets fill operational "go to war" cockpits, but also include "parasite" operational billets for leading-edge aircraft that are manned only with experienced pilots. One past example of a parasite requirement was the F-117 Nighthawk stealth fighter. The 18X pipeline will reduce

the numbers of parasite RPA billets among traditional pilot inventories, but not entirely. General Whitmore stated in his 2011 *Air Force Magazine* interview: "In the future, the RPA community is going to be a mix of traditionally trained pilots and 18X".[41]

AFPC fills its remaining pilot billets in the order of: flying training billets (SUPT and IQT instructors), non-flying remote tours, Air Liaison Officer tours, and finally, staff tours. Due to this hierarchy, many non-flying staff tours go unfilled and are considered the assignment system's "shock absorber" during pilot shortages. The 2005 Air Force policy was to man all cockpits at 100 percent, while certain staff billets were only required to be filled at 67 percent. This is not to be read as diminishing the importance staff tours play to career broadening and the overall health of pilot inventories. According to the 2005 AFIT fighter/RPA manning study, the effects of long-term shortages of individuals to serve staff tours include "(a loss of) the war fighter's insight and experience in key planning and decision-making organizations".[42] Extended 18X RPA pilot shortages to fill similar staff tours could have similar impacts on the developing 18X community.

3. Production /Absorption

The third major strength factor of Air Force pilot inventories outlined in the 2005 AFIT fighter/RPA manning study is pilot production. Traditional pilots progress through IFT, SUPT and initial qualification training courses in training squadrons before completing "top-off" training in operational squadrons to achieve mission-ready status. 18X pilots follow a similar but faster path, due to shorter syllabi.

Absorption is a unit's ability to take in new pilots while maintaining operational readiness and is dependent upon the number of experienced squadron pilots, who lead both training and

operational missions. The 2005 AFIT fighter/RPA manning study explains the results when a squadron's absorption capacity is exceeded:

> When too many new pilots are absorbed, experience levels drop, and the time required to become experienced increases.[g] As the number of inexperienced pilots increases, total unit manning must also be increased well above 100 percent in order to achieve a minimum experience level. Over-manning exacerbates the problem and also increases the average time required for inexperienced pilots to reach experienced status. . . . The combination of the two problems is a situation that can't be maintained in the long term. The problems compound, leading to lower levels of experience and higher manning—basically spiraling out of control unless outside action is taken (i.e. stop the flow of inbound pilots). [43]

The Air Force considers a fighter squadron "healthy" if it is manned at 100 percent, with a minimum of 40 percent being experienced pilots (50 percent is ideal). This ratio provides maximum readiness and maximum absorption.[44] Traditional squadrons must balance training sorties for inexperienced pilots against continuation training[h] sorties and mission/instrument check rides required for all mission-ready aircrew. Additional limits on training sorties come from exercises like Red Flag, and operational deployments (including pre-deployment work-up missions). Training sorties are even more restricted in operational RPA squadrons, leading to some radical solutions. A few examples are found in a 2009 *Air and Space Power Journal* article:

> The tremendous demand for Predator coverage has forced maximum operational efficiencies. . . . Comparing such programs to those of traditionally crewed aircraft, one finds at least two noteworthy differences. First, the operational Predator and Reaper squadrons, 99 percent of whose operations are real-world contingencies, do not carve time out of their (annual) flying-hour program to meet training requirements. Second, uninterrupted contingency operations question the relevance of many of the currencies typically maintained by pilots. Elimination of takeoff and landing currencies, for instance, has caused significant changes to the Predator training syllabus.[45]

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g. Due to fewer training sorties per month and fewer experienced instructors per new pilot.

h. Continuation training sorties are those required for a squadron's particular weapons or tactics.

The *Flight Plan* adds that "current RPA training resources provide limited flexibility to expand production capacity as RPA ISR demand continues to grow exponentially."[46]

These RPA training limitations will likely change the Air Force's ideal ratio of experienced to inexperienced pilots required for "healthy" RPA squadrons. However, the 18X pipeline is certain to change the demographics of the current RPA pilot inventory. Figure 2 is a 2010 AFPC snapshot of the majority of the Air Force's 600 RPA pilots, shown by rank:
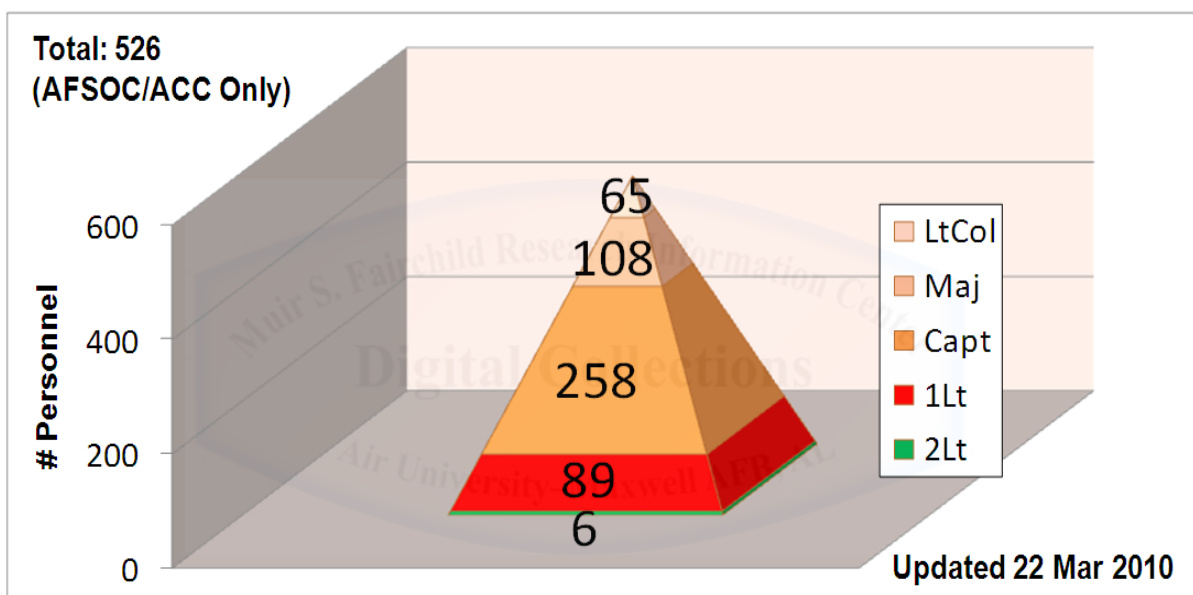

Figure 2. Breakdown of RPA pilot inventory, March 2010.[47]

The large number of RPA captains in Figure 2 resulted from filling pre-18X billets with traditional pilots. New 18X graduates will increase the number of junior pilots, potentially balancing out the current preponderance of experienced traditional mid-level pilots.

From General Whitmore's 2011 *Air Force Magazine* interview: "(Though USAF officials have yet to establish an official target end strength for RPA pilots), as we're building and trying to formalize (the 18X) program, we're looking at approximately 60 or so pilots going through annually, growing to about 170 to 180 annually over the next few years."[48] Air Education and

Training Command has a planned capacity to produce more than 180 18X pilots per year in anticipation of other DoD branches and allied interest in the program.[49] If the 18X pipeline produces 60 graduates per year from 2011 to 2016, they will compose only 18 percent of the *Flight Plan'*s goal of 1,650 RPA pilots by 2016. If production increases to 180 graduates per year after 2012, the percentage grows to 47 percent by 2016. The actual percentage will likely fall between these upper and lower bounders, but it remains to be seen if even the maximized production rate will be sufficient.

Unique 18X Pilot Production Issues

In a 2009 *Air and Space Power Journal* roundtable discussion on Air Force RPA assimilation,[50] retired Air Force Col Richard Szafranski mentions Moore's law,[i] which for the last 40 years has reliably predicted that microprocessor performance will double every 18 months.[51] Solutions to technological RPA challenges will rely on the continuation of this rapid pace of processor improvement. The RPA career field must also address human-factors challenges that beset manned-aircraft communities.

Technological RPA Challenges

Despite the relatively low operating costs of RPAs, their increasing use and cutting-edge technology raises three major technology-related challenges. The *Flight Plan* identifies three important obstacles to the success of the 18X syllabus and community: 1) increase RPA simulator use, 2) establish DoD and FAA policies covering 18X pilots, and 3) reduce RPA satellite-data bandwidth requirements. Solutions will not only solve near-term problems, they will also strengthen the chances of successful long-term RPA operations.

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i. "Moore's Law (is) named after Intel co-founder Gordon Moore, who in 1965 predicted that the density of transistors on integrated circuits would double every 18 months or so. Physics, along with ingenuity and investment, (has) made that forecast of performance-doubling every year and a half accurate so far." Steve Lohr. *nytimes.com.*

1. Increase the use of high-fidelity (HF) simulators.

There are many advantages of HF simulators over actual RPA training flights. Simulator missions are obviously safer and much cheaper by training-hour than flights, and can be programmed to provide students with an expansive range of malfunction and tactical scenarios that would be dangerous or impractical to attempt in reality. The *Flight Plan* calls for maximized use of high-fidelity simulators in the IQT course: "A distinct advantage some RPA programs possess over manned aircraft programs is the applicability of high-fidelity simulation for initial qualification training. All major Air Force large RPA programs will develop robust simulation to support nearly all initial qualification training. . . . The goal is 100% of IQT to be accomplished in simulators as soon as possible."[52] The *Flight Plan* notes that because RPAs did not arise from "a classic acquisition development and fielding program", only one of the five operational Air Force RPA programs currently meet this goal. Correcting this shortcoming will increase the efficiency of the IQT course, better preparing its graduates for the increasing complexities of operational RPA missions.

2. Establish FAA certification policies for 18X pilots.

The 18X syllabus contains no flight events after IFT at Pueblo, yet graduates fly medium and large RPAs that require de-confliction from other aircraft. De-confliction includes a pilot's basic see-and-avoid responsibility, should other avoidance systems and procedures fail. The *Flight Plan* calls for a technological solution to see-and-avoid in RPAs: "With the pilot on the ground, the Air Force is exploring advanced, reliable sense-and-avoid technologies to replace the see-and-avoid requirement. Some of this technology already exists with commercial aircraft using a traffic collision avoidance system." The DoD's strategy is to "incrementally develop RPA airspace policies, procedures, and material capabilities in partnership with the FAA to support

DoD's fiscal year 2010-2015 RPA bed down plan. This includes resolution of issues surrounding airworthiness, pilot/operator training standards and communications."[53] The unstated expectation is that rapid technological improvements will enable these time-critical initiatives.

3. Reducing Satellite Data Bandwidth Requirements

The voracious demand for RPA missions feeds the DoD's unprecedented appetite for US satellite-data bandwidth capacity, which is used to pass aircraft control and ISR data between RPAs and stateside ground control stations. From 2001 to 2005, DoD bandwidth requirements increased more than eightfold, due in large part to RPA anti-terrorist operations in Afghanistan.[54] Introducing more autonomous functions into RPA operations promises to ease bandwidth demand, but RPA autonomy is not risk-free.

RPAs already operate somewhat autonomously during certain phases of flight such as take off, landing and when flying to pre-programmed route points. Allowing RPAs to process more data onboard could decrease RPA bandwidth demands crew workloads. Commercially-available, automated video-processing technology could be installed onboard, enabling an RPA to alert its crew only when humans or other items of interest enter the RPA's field of view.[55] Other technological advances could eventually allow a crew to control several mostly-autonomous RPAs. The *Flight Plan* embraces RPA automation, but also recognizes the risks of automating combat processes and decisions:

> Increasingly humans will no longer be "in the loop" but rather "on the loop"—monitoring the execution of certain decisions. Simultaneously, advances in artificial intelligence will enable systems to make combat decisions and act within legal and policy constraints without necessarily requiring human input. Authorizing a machine to make lethal combat decisions is contingent upon political and military leaders resolving legal and ethical questions. These include the appropriateness of machines having this ability, under what circumstances it should be employed, where responsibility for mistakes lies and what limitations should be placed upon the autonomy of such systems. . . . Ethical discussions and policy decisions must take place in the near term in order to guide the

development of future UAS capabilities, rather than allowing the development to take its own path apart from this critical guidance.[56]

Human-Factors Challenges

The Air Force's push for increased RPA automation is an effort to maximize, but not replace, the human element in RPA operations. When discussing the publication of the *Flight Plan* in 2009, Air Force Vice Chief of Staff Gen Will Fraser said "I think it's certainly worth emphasizing that unmanned systems are unmanned in name only. So while the operator might not be sitting in the cockpit, at the heart of these unmanned systems—and really at the core of all of our missions—are highly skilled airmen of which we're very proud."[57] The Air Force's RPA manning policy of using commissioned pilots versus non-rated enlisted operators was influenced by the US Army's difficulties in initially employing the Predator in the mid-1990s. Gen Ronald Fogleman, former Air Force Chief of Staff, realized that the enormous potential of RPAs would require highly-competent crews as RPA capabilities matured. In discussing the genesis of sending traditional pilots to RPA tours (many non-voluntarily), he said "If (the Air Force Predator) program fails, it won't be because of our pilots."[58] General Fogleman's successor, Gen John Jumper, further justified this policy, stating "If you treat (the Predator) like an airplane, it will act like an airplane. . . . We were trying to get the accident rate down and get the operator caused accidents down. We knew if we crashed a bunch of these things that we weren't going to get [the program] either. That's why we insisted on pilots."[59]

Although initial Predator mishap rates were high, the *Flight Plan* puts these mishaps in perspective by comparing them with those of the Air Force's largest manned fighter community, the F-16:[60]

> Demand for RPAs has dramatically risen, (and) the absolute number of mishaps has also grown [but mishap numbers have decreased as a function of flight hours]. Since the inception of the MQ-1, the aircraft's cumulative mishap rate is 14 per

every 100,000 flight hours as compared to F-16's mishap rate of 11. Although still higher than the F-16, the MQ-1's mishap rate has substantially decreased from 28 Class A[j] mishaps during the first 100,000 flight hours to fewer than seven for the most recent 100,000 hours. In the USAF's small RPA community, there have been no Class A or B[k] mishaps to date.[61]

The *Flight Plan* cites the conclusion of a 2004 Defense Science Board study of RPA accidents that states the majority of these accidents shared the same root causes as manned aircraft accidents—human and material factors. For all the promises of HF simulators and automation, developing strong piloting skills and airmanship will remain vital to the success of the 18X syllabus and career field. While many 18X students are motivated "tier one" individuals, they must be adequately trained to prevent a "capability gap" between 18X and traditional pilots.

Fostering 18X Leaders

The 18X syllabus will be continually shaped by operational lessons learned and technological breakthroughs. In describing the future of the 18X syllabus, Lt Col David DuHadway, Chief of Air Force rated force policy, said "We're talking about creating a whole new way to train pilots. We will be training a group of pilots that will be one of the largest in the Air Force."[62] This large community will require leaders of the highest caliber, as recognized in the *Flight Plan*: "Since (RPAs) are becoming a greater proportion of USAF operations, career path development for all associated operations and logistics personnel needs to account for this reality." These tactical,

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j. On the *Flight Plan*'s publication date, Class A mishaps were mishaps resulting in one or more of the following: 1) direct mishap cost totaling $1,000,000 or more, 2) a fatality or permanent total disability, 3) destruction of a DoD aircraft. A destroyed RPA was not a Class A mishap unless the criteria in 1) or 2) were met.

k. On the *Flight Plan*'s publication date, Class B mishaps were mishaps resulting in one or more of the following: 1) direct mishap cost totaling $200,000 or more but less than $1,000,000, 2) a permanent partial disability, 3) inpatient hospitalization of three or more personnel.

operational and strategic 18X warriors will be more effective leaders if their words are backed with the weight of RPA successes.

18X Courses of Action

Although the specific numbers of planned 18X graduates per year are somewhat nebulous, two basic courses of action (COA) can be developed, one "conservative" and the other "maximized" in terms of yearly 18X pilot production. Each COA has advantages and disadvantages, but comparing them is useful for evaluating the best way ahead. Figure 3 at the end of the section is a summary of the "pros and cons" of each COA.

Course of Action 1: Produce a conservative number of 18X graduates 2011-2016.

COA 1 is the more cautious of the two and emphasizes the challenges facing the 18X concept and the entire RPA community. It is based on a gradual increase in the number of graduates over the next five years, starting with 60 planned graduates in 2011. Although a gradual rate of increase may fail to meet the goal called for in the *Flight Plan* of roughly 1,000 additional RPA pilots by 2016, there are valid reasons to take such an approach. It should be emphasized that, per Air Force's policy, these additional 1,000 pilots will be a mix of traditional and 18X pilots regardless of which COA is implemented.

A major short-term disadvantage of this COA is obvious: operational burdens on RPA squadrons will not be as effectively alleviated the longer that the number of 18X graduates is kept relatively low. A long-term drawback of this COA is that the pool of future 18X leaders is smaller, decreasing the number of "tier one" 18X graduates available to form the vital 18X leadership cadre that will be increasingly necessary as 18Xers enter their mid-level years. Developing an 18X warrior culture may also be inhibited if fewer 18X graduates enter the RPA community, making them the minority of RPA pilots for longer than absolutely necessary.

There are a number of advantages to proceeding with caution. Despite good results from the five 18X beta classes, the average performance of 18X graduates as compared to traditional pilots has not been fully assessed. However unlikely the chances of a capability gap between the two groups may seem, such a gap could result from rapid advances in RPA capabilities and future mission complexities. Should a gap develop, COA 1 keeps more traditional pilots in the RPA community until additional 18X training and experience can be applied to resolve it. As necessary events that the 18X syllabus currently lacks are implemented, smaller numbers of 18X graduates in the RPA pilot inventory will translate into fewer 18X graduates who need additional training in their over-tasked operational squadrons. Finally, COA 1 would retain more traditional, rated pilots to fly domestic RPA missions in FAA-controlled airspace until the issue of how to certify 18X settled.

Course of Action 2: Maximize the number of 18X graduates 2011-2016.

COA 2 also accounts for the many challenges facing the RPA community, but focuses on maximizing the advantages offered by the 18X syllabus and career field. The disadvantages of COA 1 are strengths in COA 2, which offers both the short-term benefit of helping to meet the demand for RPA pilots, and the long-term benefit of increased leader development from a larger group of 18X graduates.

There are potential disadvantages to COA 2 that must be considered. Given the extremely limited amount of training events in operational RPA squadrons, there is no traditional absorption rate to exceed, per se, but a severe shortage of training opportunities greatly increases the difficulty of completing the training of 18X graduates after they become operational pilots. In the worst-case scenario, 18X syllabus deficiencies could lead to operational mistakes involving fratricide, which could severely damage the combat reputation of the RPA community and its

developing warrior culture that is needed for 18X leader development. Lastly, all three technological challenges to the 18X community identified in the *Flight Plan* (HF simulators, the FAA see-and-avoid requirement and increased autonomy) rely on Moore's law of rapid developments for solutions. Control of multiple RPAs by a single crew makes the need to properly prepare them for such a unique and demanding mission even more important.

Figure 3 is a summary of the COAs 1 and 2.

Course of Action	Pro	Con

COA 1: Conservative 18X Syllabus Output	• **More traditional pilots in operational squadrons**
	  ○ Mitigate capability gaps
	• **18X syllabus shortcomings fixed easier at Randolph AFB**
	  ○ Slower rate of 18X graduates reduces additional training needed post-winging
	• **More traditional pilots allows more options until FAA issues resolved**
		• **Short term:** time-critical pilot demand met slower than in COA 2
		• **Long term:** Future 18X leaders develop slower
		  ○ Smaller pool of 18X graduates
		  ○ 18X RPA warrior culture inhibited by smaller numbers of 18X graduates

COA 2: Maximized 18X Syllabus Output	• **Short term:** Time-critical pilot demand met faster than in COA 1
	• **Long term:** Future 18X leader pool developed earlier
	  ○ More tier one and fewer tier three pilots sooner
	  ○ 18X RPA warrior culture could develop faster
		• **Risk exceeding "absorption" rate**
		  ○ Could lead to excessive training burden for operational squadrons.
		• **Possible capability gap increases the risk of RPA community setbacks**
		  ○ Operational errors
		  ○ 18X leaders lose credibility
		• **Reliance on Moore's law for time-critical technology**

Figure 3. 18X course of action summary

RECOMMENDATIONS

Since its establishment in 1947, the Air Force has embraced technology. Although some piston-driven fighters of the time outperformed early US jet fighters, the Air Force invested heavily in this revolutionary technology and rapidly built jet-powered aircraft fleets after World War II. Jet engines were less complex than piston engines and burned less refined (thus cheaper) fuel. Technological and human-factors challenges were overcome, and jet aircraft became fixtures of military operations throughout the world. RPAs will likely follow a similar developmental pattern, due to the unceasing demand for their growing capabilities and relatively low costs.

The basic strengths of RPAs makes it essential for the US to maintain its current advantage. Compared to manned aircraft, RPA production and training costs are extremely low, making them accessible to a range of enemies, from foreign nations to "back yard terrorists". These enemies can improve and weaponize RPAs much more quickly by than many other weapons systems. United States allies and near-peer competitors are increasingly motivated to close the "RPA gap" held by the US. For these reasons, it is prudent to take full advantage of the benefits of the 18X syllabus to increase RPA pilot numbers, but in a way that supports their continued success on increasingly difficult training and operational missions.

Recommendation: Maximize 18X pilot production.

Implementing the 18X syllabus to the maximum practical limit will help maintain the Air Force's considerable lead in RPA expertise. Cost savings aside, the 18X syllabus is attracting potential "tier one" pilot candidates who will guide the future of this force. Using COA 2, the 18X pilot syllabus should be implemented as fully as possible, but with an awareness of the inherent risks and assumptions accepted.

Recommendation: Include RPA simulator events in the 18X syllabus.

The *Flight Plan* calls for all initial qualification training of 18X graduates solely through use of HF simulators once they enter IQT courses in their RPA training squadrons. As simulator technology matures, the benefits of installing RPA simulators at Randolph AFB should be explored. The current 18X syllabus uses a number of T-6 Texan II aircraft simulators to instill basic aviation skills. Two types of T-6 simulators used today include Instrument Flight Trainers (IFT) which lack video screens to display a computerized version of the "outside world", and Operational Flight Trainers which project such imagery onto the wall of a large wraparound screen. Simplified versions of HF RPA simulators analogous to simpler, yet effective, IFTs can be incorporated into the Randolph's RPA fundamentals course to give students a realistic taste of what awaits them in operational units. Additional benefits of RPA simulators at Randolph follow.

First, the specific skills required of RPA pilots will be refined through lessons learned from IQT course performance and operational missions. This may shift the emphasis from T-6 simulator "airmanship" events at Randolph in favor of RPA-centric events. Regardless of the number of T-6 events needed, additional RPA simulator events will likely require syllabus extensions of only a few weeks. Second, identifying and correcting common deficiencies in the required skills of 18X pilots early in the training process will benefit students and their RPA training units. These benefits include fewer failed IQT training events or IQT student eliminations after considerable time has been invested in their training. Finally, providing 18X students a taste of what operational RPA missions will require of them will increase their understanding of "big picture" airmanship concepts taught at Randolph.

Recommendation: Implement RPA "exchange tours" to develop 18X leaders.

RPAs are playing a larger role in Air Force combat missions in Afghanistan, Iraq and other areas. Continuing successes can be used to overcome RPA cultural barriers by increasing the "warrior credibility" of emerging 18X leaders. As 18X pilot production meets RPA manning demands, select "tier one" individuals can serve tours in other Air Force units that are operationally related to RPAs. Such "exchange tours" will provide 18X pilots valuable insights on the limitations and opportunities facing the RPA community. E-3 Sentry Airborne Warning and Control System (AWACS) and E-8C Joint Surveillance Target Attack Radar System (JSTARS) squadrons are ideal host units, due to their ISR commonalities with RPAs and their ability to include 18X pilots on missions. Reaper pilots serving as Air Liaison Officers will be RPA ambassadors and gain "ground-level" experience in RPA strikes by working with Joint Terminal Attack Controllers and Forward Air Controllers.

A policy of allowing 18X pilots to switch among different RPA communities from one tour to the next will "cross-pollinate" the RPA community, generating fresh perspectives and ideas among RPA pilots. For example, a Predator tour followed by a Global Hawk tour will be invaluable to 18X pilots as they rise to senior RPA and combat Air Force leadership positions.

One promising development in the RPA warrior culture was the graduation of the first class of Predator pilots from the Air Force's prestigious Weapons Instructor Course (WIC) in 2009.[63] These graduates are the initial cadre of seasoned RPA experts called for the in the *Flight Plan*. In addition to serving as WIC RPA instructors, promising 18X graduates can "advertise" their community though the increased numbers of Randolph instructor assignments that installing RPA simulators there will bring. Top-quality 18X graduates who return to instruct at Randolph

will benefit 18X students, develop their own leadership skills and help transcend traditional pilot misconceptions about the 18X career field.

CONCLUSION

The future of the 18X community lies in balancing a number of factors. The demand for RPA pilots will be met by balancing an increased number of 18X graduates, but in a way that maximizes their chances to succeed in advanced training and operational squadrons. The ability to train new RPA pilots using HF simulators is balanced by the current capabilities of simulator technology. Technology-based RPA improvements are balanced by the need to keep human operators either "in" or "on the loop". Finally, the Air Force's need for operational RPA pilots should be balanced by allowing them to develop leadership skills outside their RPA cockpits.

There will never be a final answer to these issues—merely a best solution at any particular time. This paper is an attempt to capture the current state of conditions to help guide decisions concerning future operators of this important military asset. Like most complex questions, the way forward will be decided using an assessment of historical lessons, recognition of current limitations, and a vision of what is possible.

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Appendix

List of Acronyms

NOTE: This is a list of frequently used acronyms from this paper and is not all-inclusive.

AFIT   Air Force Institute of Technology

AFPC   Air Force Personnel Center

HF   high-fidelity (simulators)

IFT   introductory flight screening

IQT   initial qualification training course

ISR   intelligence, surveillance and reconnaissance

SUPT   specialized undergraduate pilot training
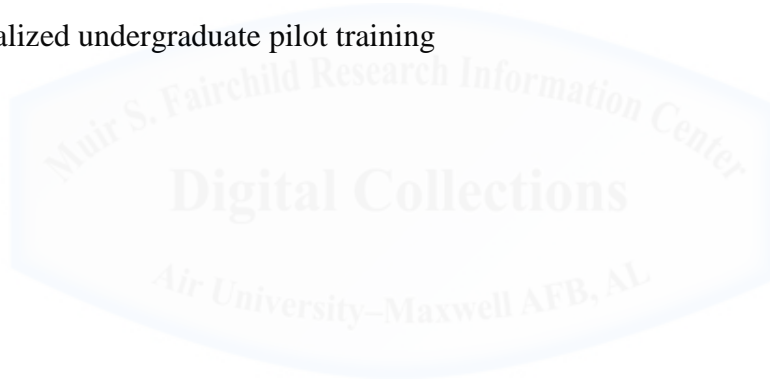
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